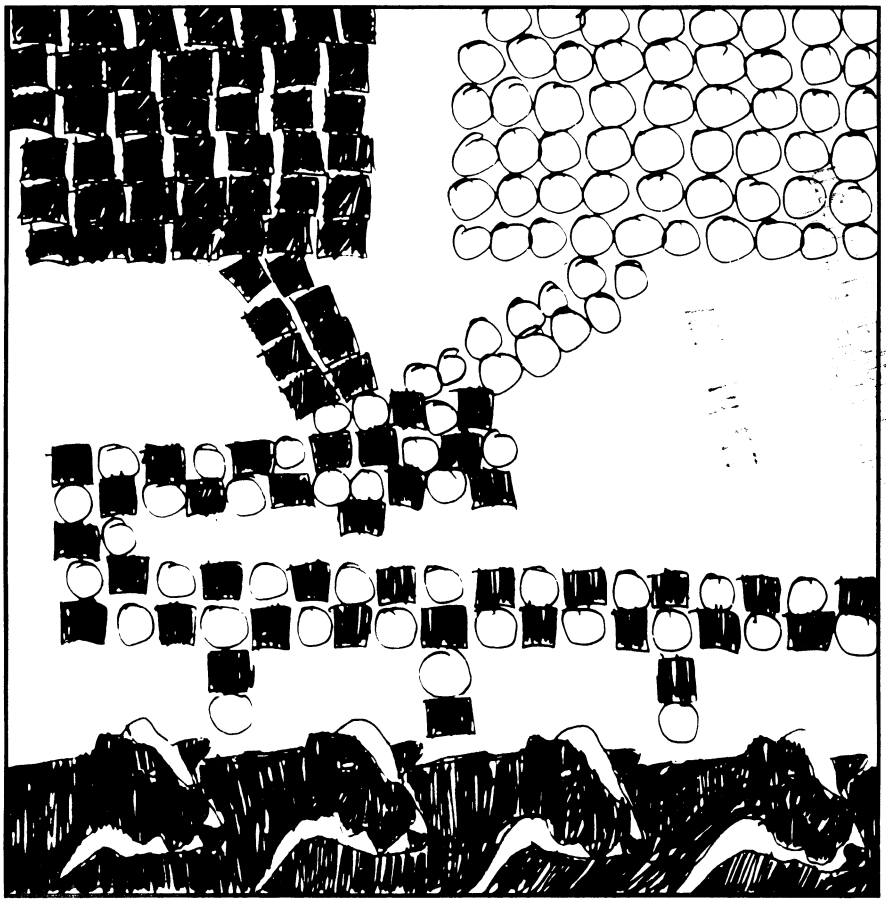
Automatic Feeding Equipment for Livestock and Poultry



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CONTENTS

AUTOMATIC FEEDING EQUIPMENT FOR LIVESTOCK AND POULTRY

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On many farms, handling and processing feed for livestock and poltry is laborious, time-consuming work.

Mechanization and automation of the feeding operation can—

- Reduce the amount of labor required (thereby reducing labor costs and freeing labor for other farm work).
- Permit expansion of livestock and poultry production by increasing the number of animals that can be handled.

With electrical equipment and controls, feed can be removed from storage, mixed and ground to the desired ration, and be delivered to livestock or poultry with little or no manual labor.

Automatic feeding systems may be set up by adding to or modifying existing facilities and equipment or by designing a completely new layout of buildings and equipment. Whichever procedure is followed, careful planning is essential to insure an efficient and economical system.

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FEEDING SYSTEM EQUIPMENT

A feed-processing system can vary from a simple storage bin and mill to a complex grouping of completely automated equipment. A complete automatic feeding system would include:

Storage bins to store such feed ingredients as corn, other grains and supplement.

Blender (two or more feed dispensers) to blend or mix ingredients in correct proportion.

Mill or *grinder* to grind and further mix the ingredients. In some cases, the blender and the grinder may be combined as a single unit (fig. 1).

Conveyors to move ingredients from storage to processing (mixing and grinding), and ground feed from processing to feeding points. Augers and pneumatic conveying systems are examples of commonly used conveyors.

Distributors to receive feed from conveyors and distribute it before the animals. An auger mounted above a bunk feeder and a self-feeder are examples of distributors.

Automatic controls to regulate

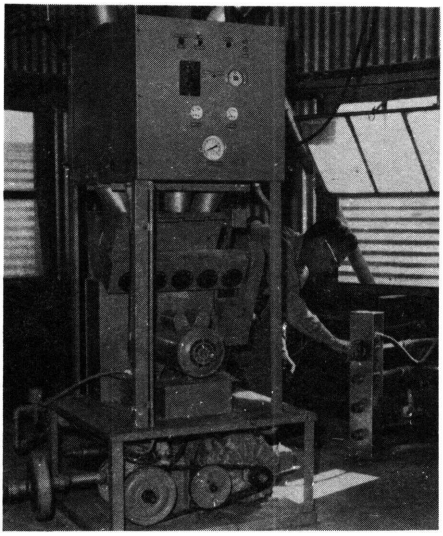

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Figure 1.—Automatically controlled augers bring feed ingredients from supply bins to this automatic mill. Here the ingredients are blended and ground and then delivered to a conveyor.

and synchronize operation of equipment components.

Storage Bins

Feed ingredients can be stored in hopper-bottom or flat-bottom bins.

Hopper-bottom bins (fig. 2) unload by gravity, which is an economical method of moving feed in an automatic feeding system. However, hopper-bottom storage usually costs more per cubic foot than does flat-bottom storage. Also, oil meals and fibrous feeds tend to cake while in storage and to bridge during discharge. This can impede unloading by gravity. The problem can be minimized by using pelleted feed ingredients.

Flat-bottom bins can be unloaded by mechanical unloaders. How-

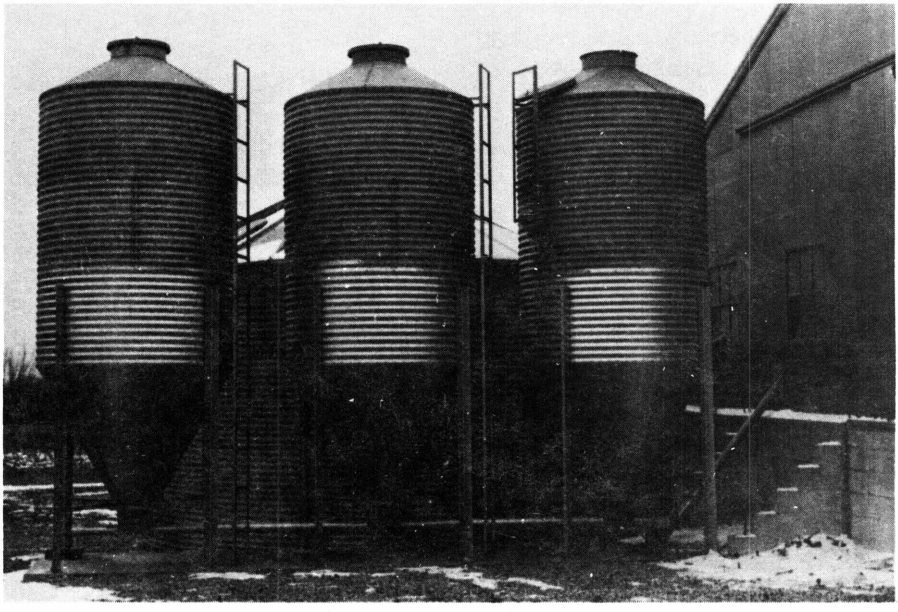

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Figure 2.—Hopper-bottom grain storage bins.

ever, with most equipment, complete unloading of the bin cannot be accomplished mechanically; the last several feet of feed must be unloaded manually.

Mechanical unloaders that almost completely unload a round or square flat-bottom bin are available. Basically, they consist of two powered augers: one sweeps around the storage bin floor, gathers the feed material, and conveys it to a hopper in the center of the bin; the other, operating below the bin floor, removes the feed material from the hopper and conveys it to the outside of the bin for transfer to another conveyor.

Mechanical unloaders are designed to unload feed automatically at the low rate desirable for automatic feeding systems. For unloading or moving feed at high rates, larger models are available.

Blender (Feed Dispensers)

Livestock or poultry feed can be mixed before or after it is ground. Mixing ingredients before grinding is discussed here.

In an automatic feeding system, feed ingredients are removed from storage, mixed or blended, and then ground and fed.

A satisfactory mixing and grinding operation requires (1) dispensers that will blend different feed ingredients in the correct proportion, and (2) a mill that will grind different size feed ingredients simultaneously.

Different types of volumetric dispensers have been tested in automatic feeding systems. The most satisfactory types include the belt, auger, fluted wheel, and vibrator.

Belt Dispenser

The belt dispenser in figure 3 is designed to dispense nonfree-flowing materials or materials that tend to compact in storage and bridge during discharge. It consists of a metal mat or rubber belt (15 to 36 inches wide and several feet long) which serves as the floor of the storage bin, and a strike-off gate to regulate the amount of material pulled from the bin. Although out-put varies with operating conditions (aggregate size, trash, and moisture content), the dispenser is reasonably accurate. It is the most expensive because of its low-speed, high-torque drive unit.

Auger Dispenser

An auger dispenser operates accurately at low speeds and accurately enough at high speeds (800 to 1,000 rpm) for most feed mixing. It works best when one to two convulsions of the auger flighting are exposed to the feed material, when the output rate is controlled by regulating auger speed, and when inside a blender driven by a single power source. Small automatic feed mills with integrally mounted auger-type blending units are available (fig. 4).

Fluted-wheel Dispenser

A fluted-wheel dispenser can accurately dispense free-flowing small grain and supplement. It works best in a blending unit

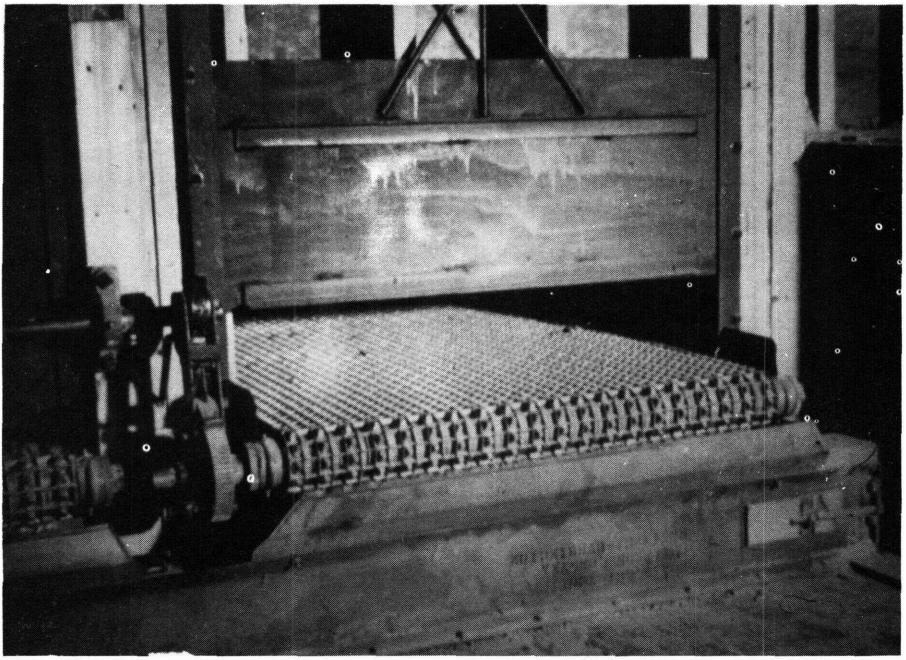

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Figure 3.—A metal belt dispenser utilizes a powered belt as the bin floor and a strike-off gate to regulate the amount of material pulled from the bin.

driven by a single power source. A small grain seeder that uses a fluted wheel to control seeding rate can also be used as a dispenser (fig. 5).

Vibrator Dispenser

The low cost vibrator dispenser is versatile, accurate, and simple to operate. It can be located at any point in a feeding system to dispense free-flowing feed material.

The dispenser in figure 6 consists of a metal box with a trough on one side, an adjustable gate, and an electric vibrator attached to the trough bottom. The vibrator operates on alternating current (a.c.); no motor is required.

Dispenser output may be controlled by adjusting the gate opening or by adjusting the current in the vibrator coil. The current can be adjusted with a series rheostat.

Although the vibrator dispenser is not easily plugged by trashy or lumpy material, such material will affect the output rate while passing through.

The vibrator dispenser can also be used for jobs that require uniform delivery of granular materials. For example, it can dispense supplement on silage as the silage is conveyed to a feed bunk (fig. 7), or it can mix feed ingredients with silage as the silage is loaded into a silo.

Figure 8 shows construction details of the vibrator dispenser. The

bottom should be of lighter gage metal than the sides so as to vibrate more readily.

The graphs in figure 9 show the dispenser capacity at different gate openings and coil voltages. At a given voltage, dispenser output—as a percentage of maximum dispensing capacity for a particular feed material—will vary according to the size of the gate opening. For example:

The right-hand graph shows that 540 pounds of soy-bean meal is dispensed in 1 hour through a 2½-inch gate opening at 110 coil voltage. The left-hand graph shows that with the same gate opening, the 540 pounds-per-hour dispensing rate is 45 percent of maximum capacity.

With coil voltage the same (but gate opening reduced 1 inch), the dispenser rate drops to 16 percent of maximum capacity, or 192 pounds per hour.

Variable Speed Drive for Dispenser

The development of the silicon-control rectifier (Thyristor) (fig. 10) has made it possible to control the speed of direct-current (d.c.) motors with a simple low-cost circuit. Many local hardware stores sell a thyristor device that will con-

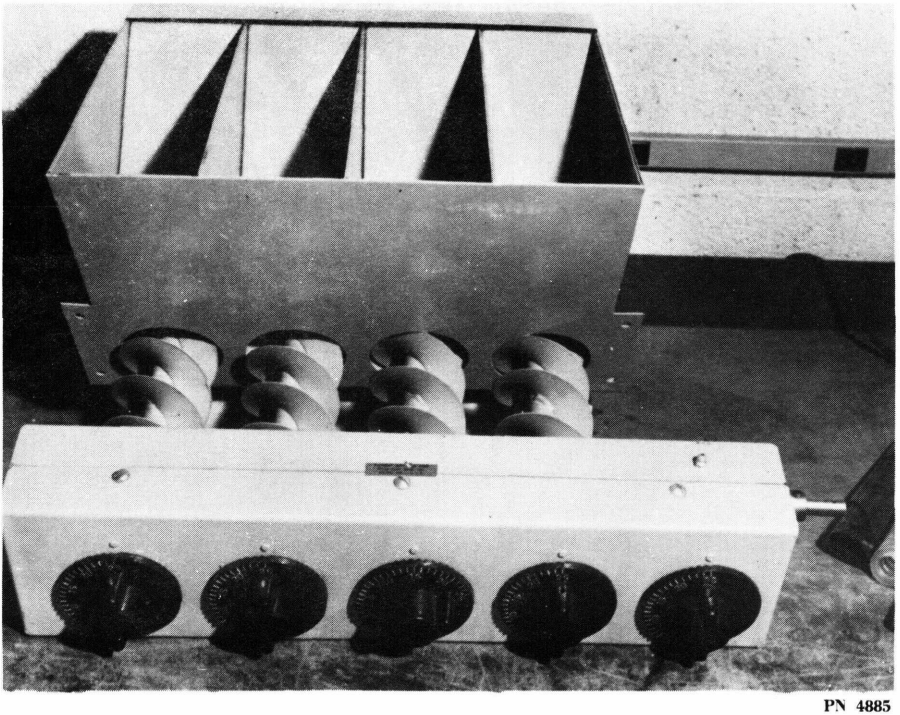

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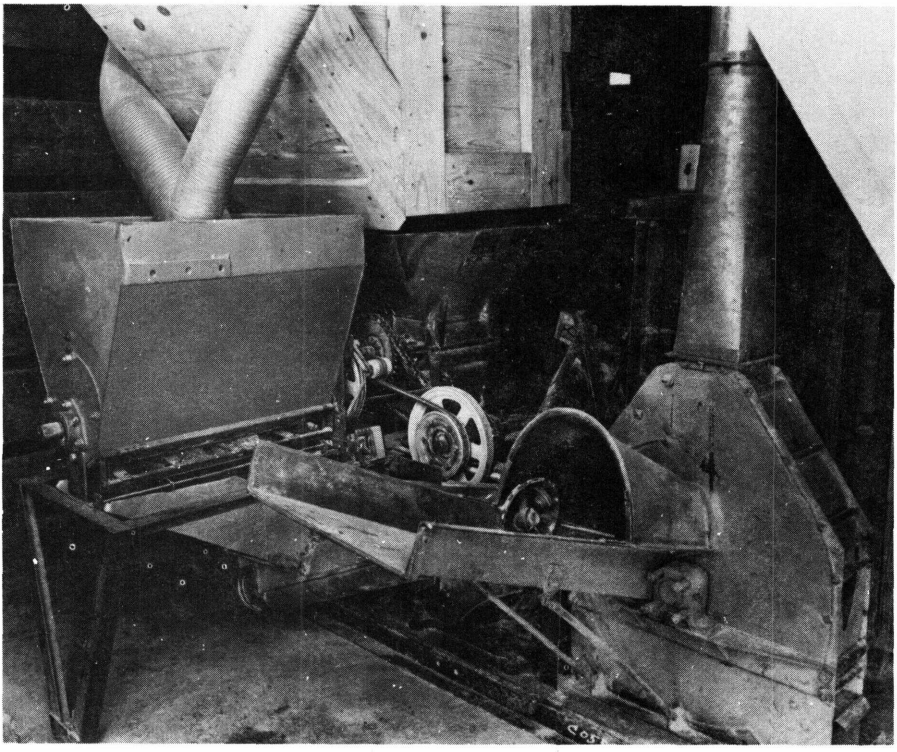
Figure 4.—The blending unit of a small, automatic feed-grinding mill. The dials regulate the average speed of, and relative speed between, the four augers.



PN 4886

Figure 5.—Small grain seeders that use a fluted wheel to control the seeding rate can satisfactorily dispense small grains in an automatic feeding system. (Courtesy of Department of Agricultural Engineering, Kansas State University.)

trol a motor's speed within plus or minus 5 percent of the rated full-load speed. A better controller that will regulate the motor speed within plus or minus 2 percent is available through electronics specialty suppliers. Both controls are relatively low in cost and have long life. When connected to low speed d.c. motors (gear motors) of $\frac{1}{30}$ to $\frac{1}{4}$ horsepower, they provide an excellent means of controlling the dispensing rate of auger, belt, or disk feed dispensers. Thus, the accuracy of variable speed and the convenience of the vibrator method for regulating feed dispenser flow can be combined, as in figure 11.

Forage Dispenser

In an automatic livestock feeding system, control of forage flow is difficult. Pelleting forage provides dense uniform material that can be dispensed by volumetric dispensers. However, pelleting forage fed to livestock is not economical because much processing equipment, time, and energy is required. Silage is a major source of forage, and equipment to handle it in semiautomatic livestock feeding system is available.

Silo Unloaders

Tower silos are of two types: The top unloading and the bottom unloading. The latter is an airtight structure.

In tip unloading silos, unloaders are either supported by the silage or by a cable from the top of the structure. Output is regulated by adjusting the cutting depth of the silage gathering nechanism. Surface supported unloaders are regulated by manually adjusting the cutting depth gage.

Cable-supported unloaders (fig. 12) are regulated by adjusting the support cable to control the depth of cut. The amperes required by the unloader motor indicates the forage load. To show motor load, an ammeter is usually mounted at the unloader control panel.

The cable-supported top unloader can be operated automatically when the unit is equipped with suitable controls. A support cable winch must be able to slowly lower an unloader if the current demand is below the desired value. Electromechanical and electronic controls are available.

The amperes required by the blower-thrower motor (fig. 13) are

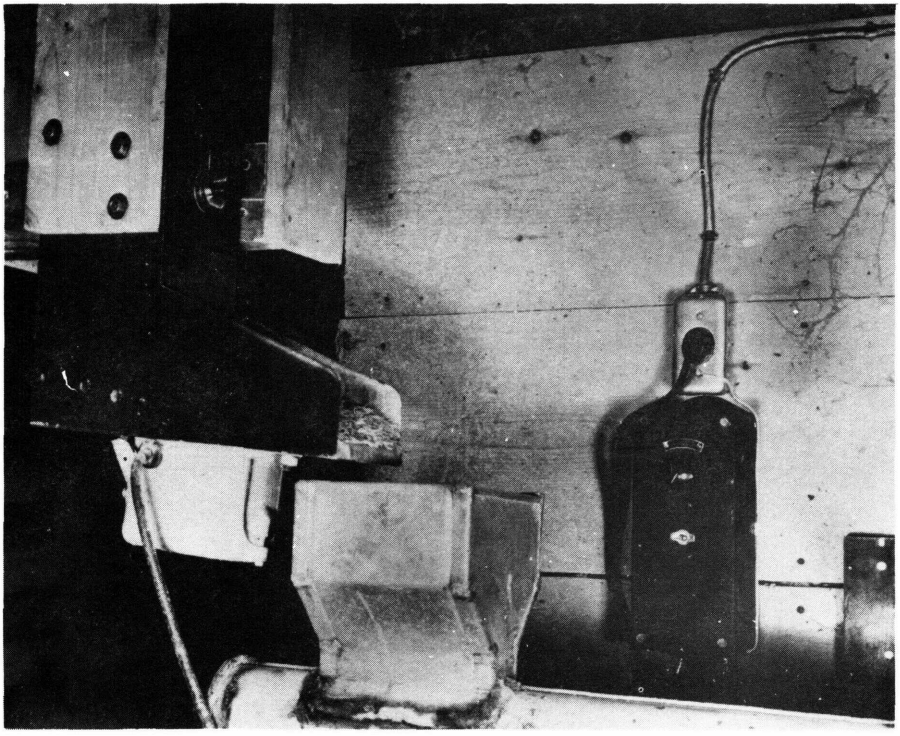


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Figure 6.—A vibrator dispenser can be used to dispense free-flowing granular materials in an automatic feeding system.

directly proportional to the mass of silage discharged per unit of time. With an electronic control, the output of the top-mounted, cable-supported silage unloader can be regulated to provide a near constant rate of discharge plus or minus 10 percent of the average desired rate.

Silos with bottom mounted unloaders are usually oxygen-free or air-tight silos. The unloader has a

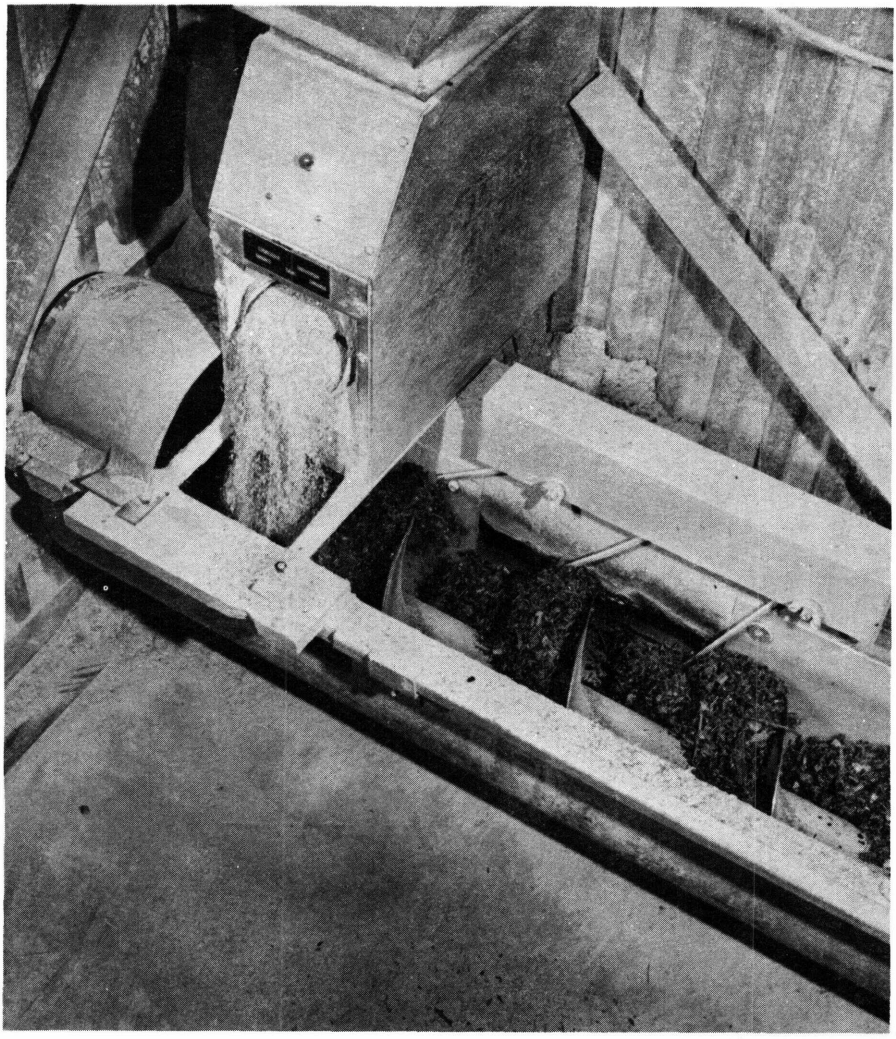

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Figure 7.—On the left is the auger feed dispenser, using solid-state speed-regulating controls. The processed concentrate mix is stored in a tank just above this dispensing unit. On the right are three vertical sensing fingers that operate paralleled switches to sense silage flow in the auger. If no silage flows for a preset time (no finger displaced), the system automatically shuts off.

strong cutting chain conveyor mounted on a rotating arm. The cutting chain draws the silage material to the center of the structure and then drops the silage into the discharge conveyor—chain or auger (fig. 14). Discharge rate from the silo by a bottom unloader is dif-

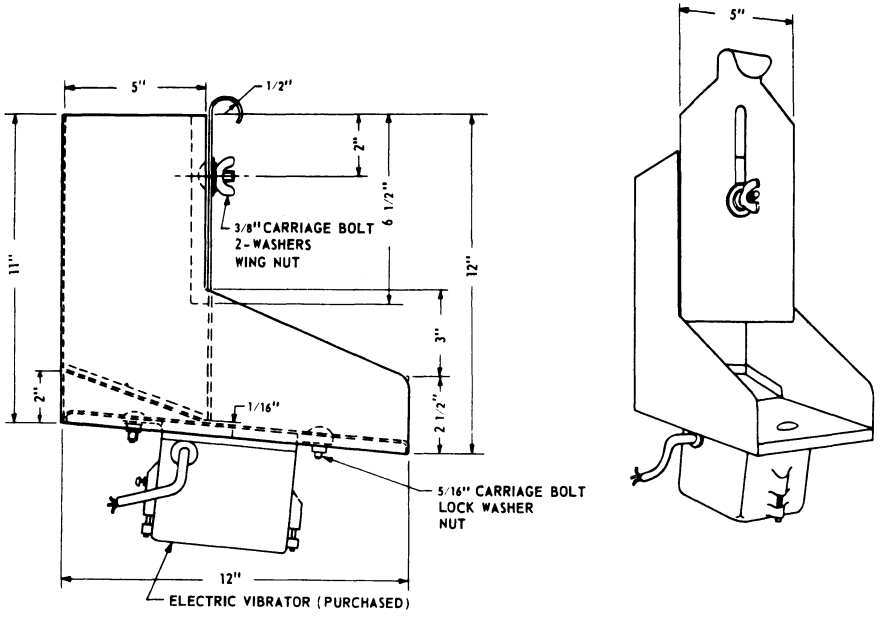

Figure 8.—Construction of the vibrator feed dispenser.

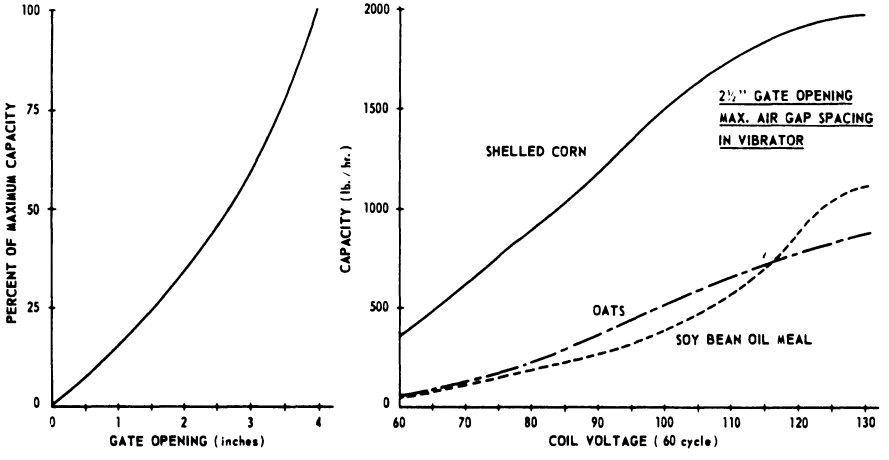

Figure 9.—Typical dispensing rate curves for the vibrator dispenser shown in figure 8.

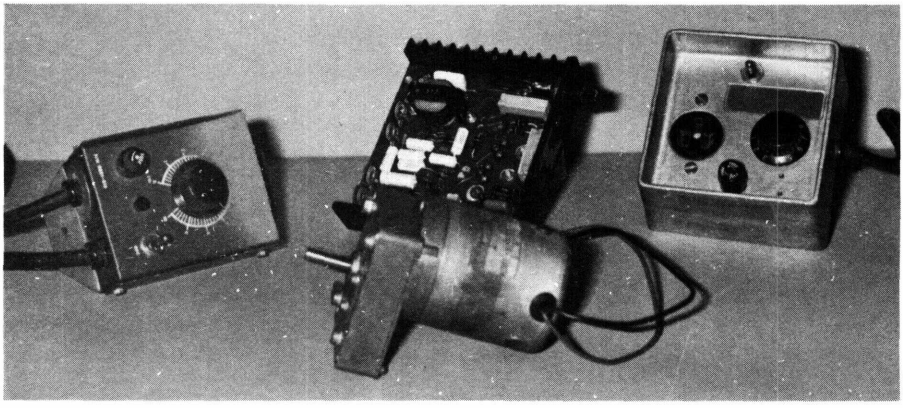

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Figure 10.—Electronic speed controls are used with d.c. motors on a number of feed dispensers (such as the auger and rotating table meter) that vary their output. Commercial control units for shunt and series d.c. motors are shown.

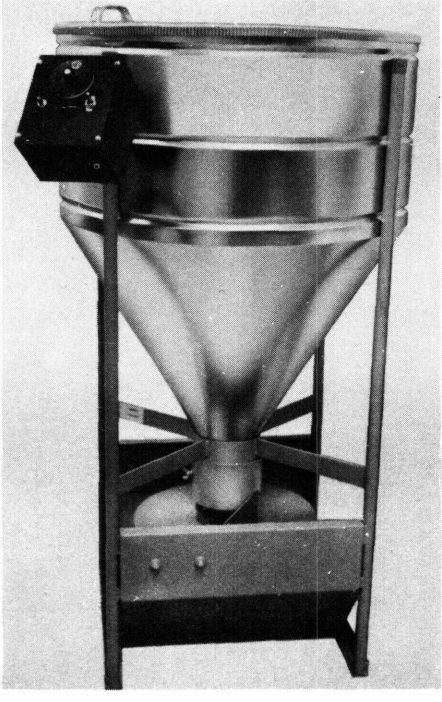
ficult to regulate. The minimum flow per minute may differ by a factor of 3 to 5.

Continuous-flow electronic scales are available which determine the total mass of material passing over them (fig. 15). By use of a preset counter (fig. 16) and a rate output function, such scales can simultaneously control dispensers for other ingredients and thereby provide a predetermined amount of a correctly proportioned livestock ration of silage and one or more other easily dispensed feed materials.

Mill (Grinder)

Mills for processing feed come in different types: hammer, burr, crimper, crusher, and roller. Each type has different sizes or capacities. The type and size needed depend on—

- Kind of feed material to be processed,



PN 4890

Figure 11.—Feed dispensers can be of many designs. The variable-speed rotating table dispenser is a common type.

- Capacity required, and
- Finished feed characteristics desired.

Hammer mills are best for fine and medium grinding; burr mills for coarse grinding.

In an automatic feeding system, feed should be processed at a low rate over the maximum period of time. Small, low-capacity, electrical equipment costs less to buy and operates more efficiently.

Small grain and supplement, including shelled corn, can be processed in a small, automatic feed grinder (2 to 3 horsepower) with an automatic control system consisting simply of adequate feed dispensers and an interval timer.

Because of higher roughage content, some cattle feeders and dairymen prefer to feed ground ear corn instead of ground shelled corn. Automatic grinding of ear

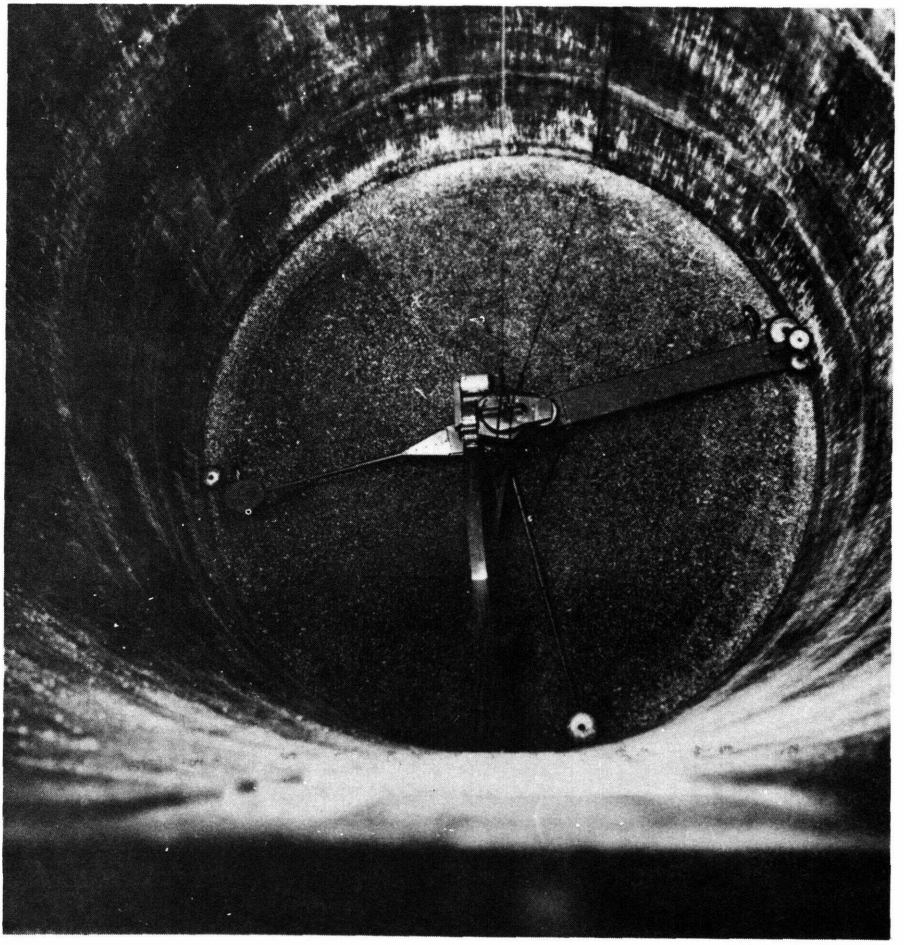


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Figure 12.—Top-mounted, cable-supported silo unloader.

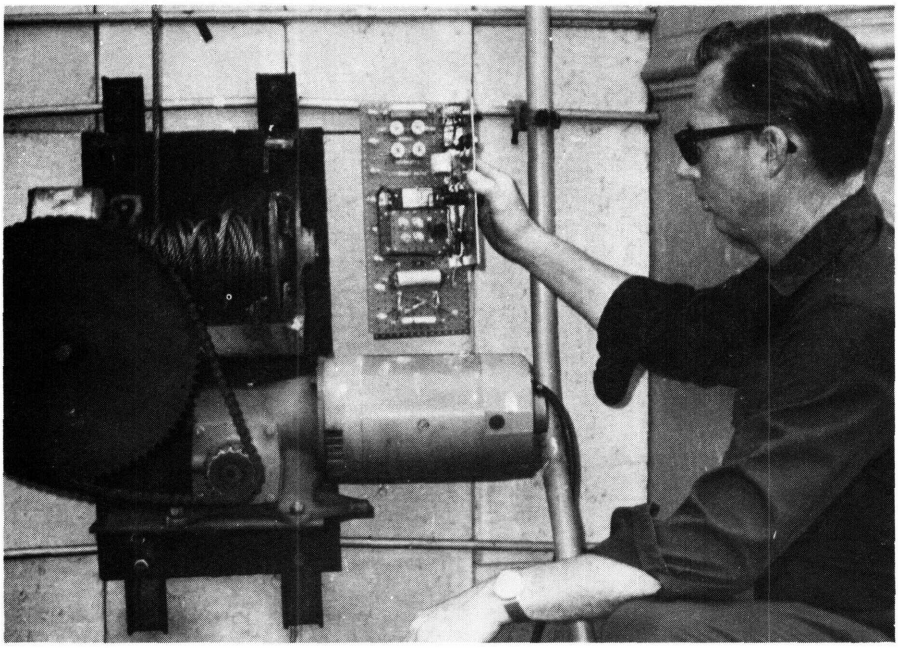

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Figure 13.—Electronic silo-unloader control that senses blower-thrower motor current, thus regulating the unloader output. The control operates the silo-unloader winch motor.

corn involves problems like uniform corn flow into the mill and smooth operation of mill and motor. Either of two methods may be used:

Precrushing

Corn can be crushed in a crusher-type mill before it is ground. A hoppered bin, sloped on two sides, can feed the corn into the crusher. An auger dispenser can dispense the material from the crusher and convey it to the mill. Precrushing ear corn provides uniform flow into the mill and, therefore, smooth operation. But an extra piece of equipment—the crusher mill—is required, and the power requirements per ton of feed ground will be the same as in the overload-control method discussed below.

Overload Control

Ear corn can be ground without crushing beforehand if the mill has suitable electrical controls to prevent severe motor overload. This method requires:

1. A hammer mill—5-horsepower, low inertia (most practical type and size for automatic ear corn grinding). The mill must have low inertia so that an increase in load will be reflected quickly as an increase in motor current.
2. A current-sensing device in the mill-motor circuit that will stop the dispenser and feed in-

put when the motor reaches a preset level. This device can be a magnetic- or electronic-type contoller (fig. 17).

3. A feeding mechanism that stops feed flow immediately. The motor may stall if feed continues to flow after the dispenser shuts off. Auger dispensers stop material flow quickly and completely (fig. 18).
4. A hopper-bottom corn crib and an ear corn crib drag to remove and dispense corn from the crib into the mill (fig. 19).

Conveyors

In an automatic feeding system, the feed moves from storage to processing (mixing and grinding) and then to the feeding points.

Equipment or methods that may be used to move or convey feed include bucket elevators, augers, and pneumatic conveying systems.

Bucket Elevators

Bucket elevators are the most efficient method of conveying feed vertically because they handle feed gently and will not damage whole grain. When large amounts of ma-

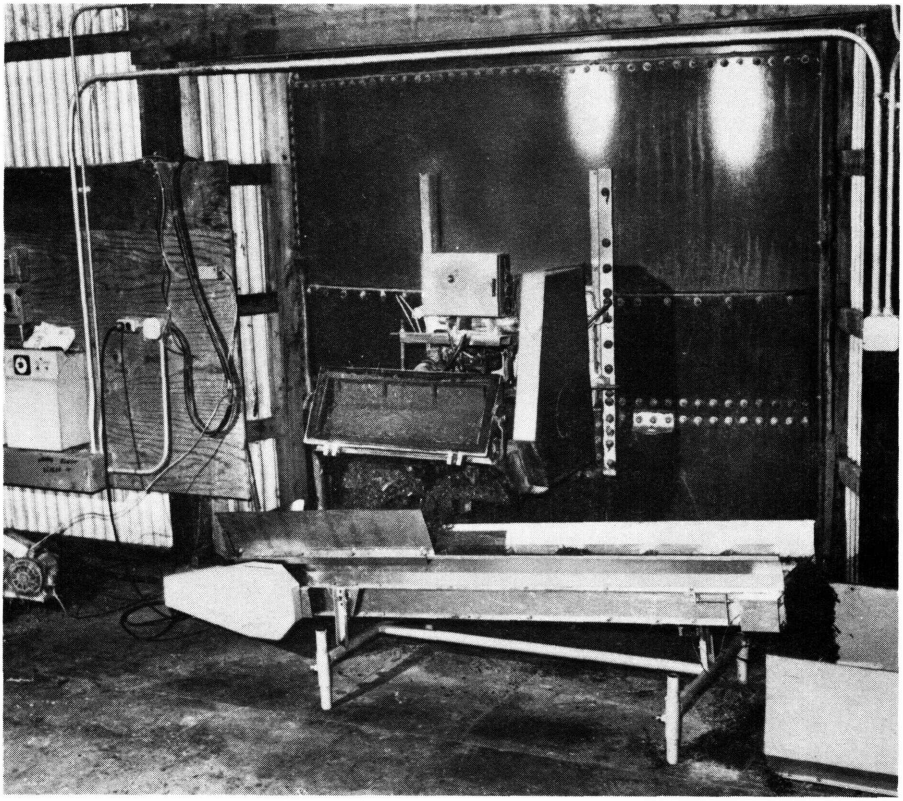

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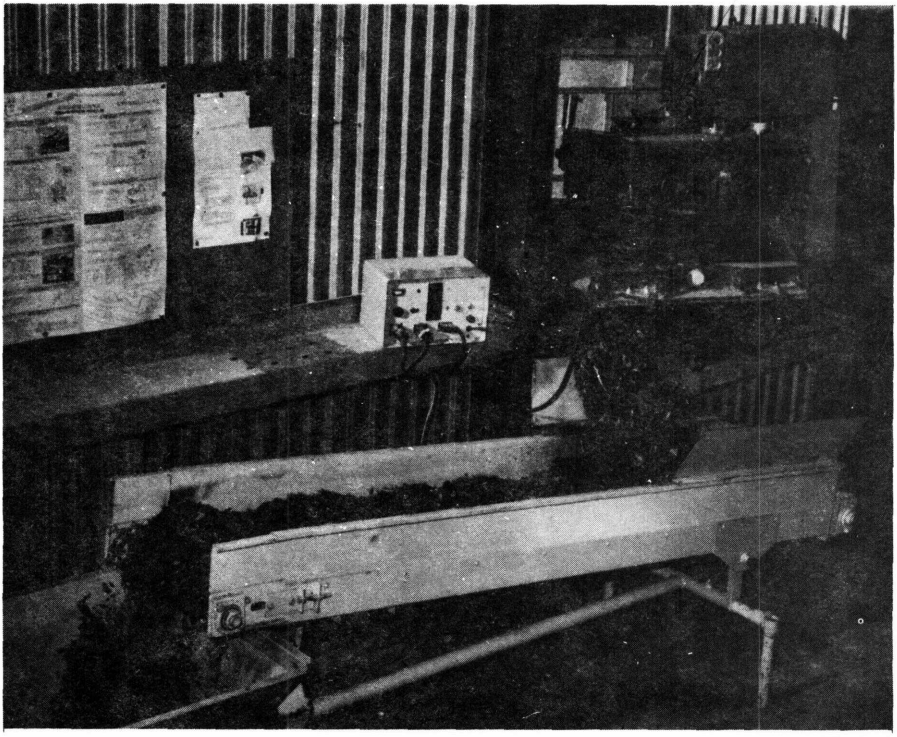
Figure 14.—Belt-type forage distributor for cattle.



PN 4894

Figure 15.—Continuous flow electronic forage weigher.

terials must be elevated and lifted 40 feet or more, and when into-storage handling or storage-to-storage transfer is required, bucket elevators work best.

Augers

In conveying materials, augers are less efficient than bucket elevators. They cause some size reduction in ground-feed particles, and damage seed material when conveying vertically. However, augers can be practical for feed-processing systems because of low cost and versatility. They can be used to convey feed from storage to processing and from processing to feeding points.

Augers are available in different sizes and in different lengths in each size. A number of auger lengths can be connected to convey feed for several hundred feet.

Auger capacity and power requirements depend on size, length, conveying angle, speed, and material conveyed. Points to consider in using augers:

- A single-powered auger is used to convey feed in a straight line only; gears or flexible shafts would be needed to change the direction. When a direction change in conveying is needed, a second auger and drive motor will probably be less expensive. A shaftless low-capacity auger can convey ma-

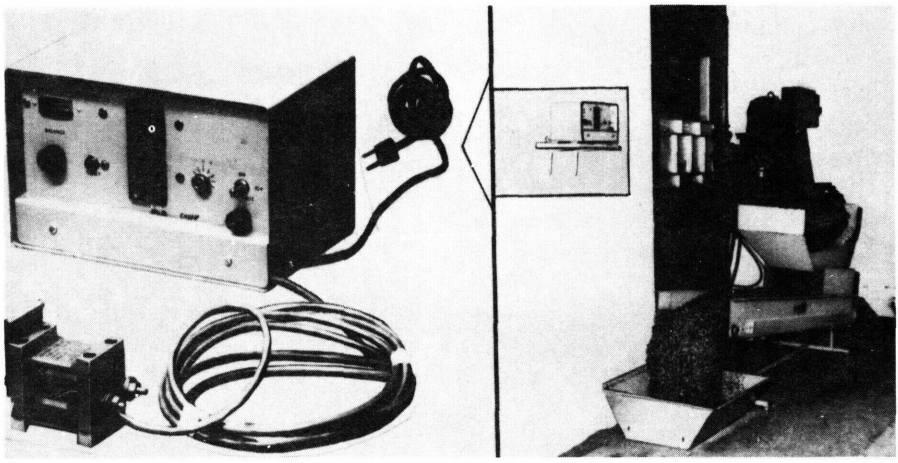


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Figure 16.—Electric scale measures the mass (weight) of material passing over it and can be used to operate a circuit that will stop delivery when a preset quantity is reached.

terial around long-radius bends, which greatly increases the versatility of the auger conveyor.

- When conveying materials *horizontally*, augers are more efficient in capacity and power requirements. (Capacity decreases and power requirements increase the steeper the conveying angle.)
- Augers should be operated at the slowest speed that provides the desired delivery rate. An increase in operating speed can increase capacity, but the power requirement also increases.
- At a given speed and delivery rate, longer augers require more power than shorter ones. For example, a 40-foot auger requires twice the power of one 20 feet long.
- Augers must have the capacity to handle the quantity of feed delivered by a preceding auger or other component of the system. For example, an auger with a maximum conveying capacity of 200 bushels of feed per hour should not receive feed from one conveying 300 bushels per hour.

Pneumatic Conveying

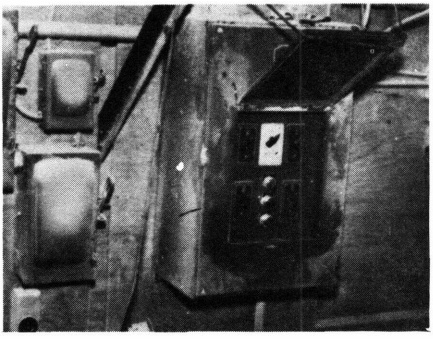
An efficient method of conveying ground feed from the storage and mixing area to feeding points is through pneumatic (air pressure) conveying. This method of blowing feed through piping offers the following advantages over mechanical conveying by belts, augers, fluted wheels, and vibrators:

- Simple construction, easier installation, includes turns.
- Less initial cost when conveying distance exceeds 200-300 feet.
- Easier servicing and maintenance because all equipment is located in one place.
- Lightweight piping can be suspended overhead or buried underground.

Two systems of pneumatic conveying have been tested and used for automatic feed distribution—

high-volume, low pressure and low-volume, medium-pressure. The basic difference between the two is the volume of air moved and the air pressure required.

High-volume, low-pressure system.—This system uses an air pressure of less than 2 pounds per square inch, which is supplied by an impeller-type blower (fig. 20). Feed can be satisfactorily conveyed about 300 feet. But the system has several disadvantages: the large-size pipe required must be carefully installed; the high volume of air moved causes excessive dust at the discharge point; feed entering the system through the blower is compacted by the blower wheel, which causes size reduction of the feed particles.



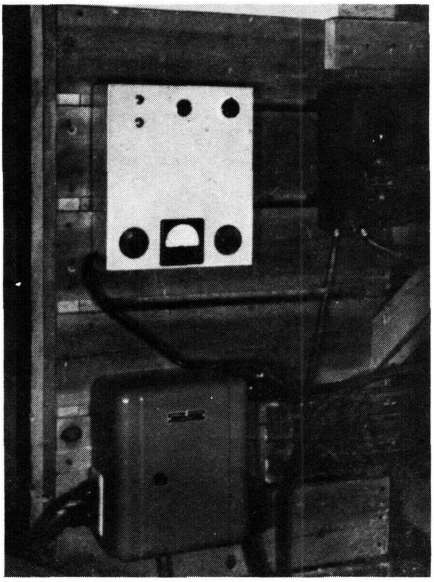


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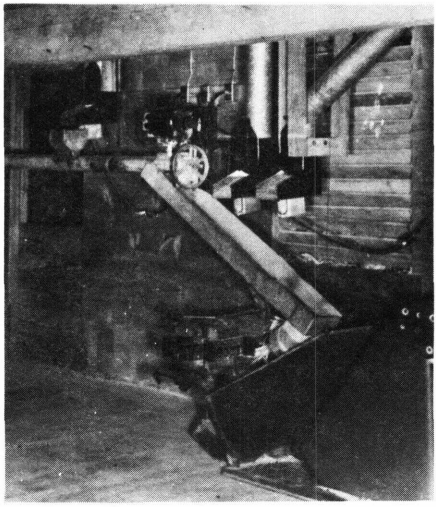
Figure 17.—Magnetic control for an ear corn grinder (top) uses a current sensitive relay to regulate operation of feed dispensers. Electronic control (bottom) uses a current transformer and electronic relay. The electric relay is more sensitive than the magnetic current relay.



PN 4898

Figure 18.—An auger can stop the flow of feed into the automatic mill quickly and completely if the mill motor becomes overloaded.

Low-volume, medium-pressure system.—This system uses an air pressure of up to 20 pounds per square inch, which is supplied by a rotary-type air pump ("roots" blower) or by a rotary vane compressor (fig. 20a). Advantages include:

- Easy installation and control and feed can be routed from one

loading point to any discharge point.

- More efficient conveying because of higher air pressure and smaller volume of air movement.
- Less dust at discharge point.
- Smaller pipe used (1 to 4 inches in diameter).

Valving and piping systems developed for commercial pneumatic conveyors of this type can be used for feed distribution on farms.

Distributors

In an automatic feeding system, ground feed is conveyed from storage bins or the mill to feeding points, where it is distributed before the animals.

- Self-feeders can be filled automatically by an auger (fig. 21) or by a pneumatic conveyor.

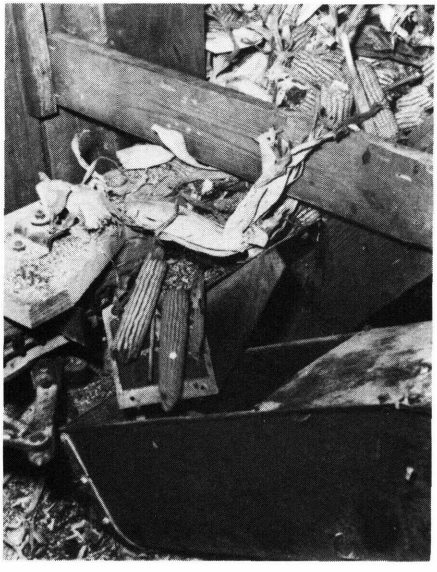


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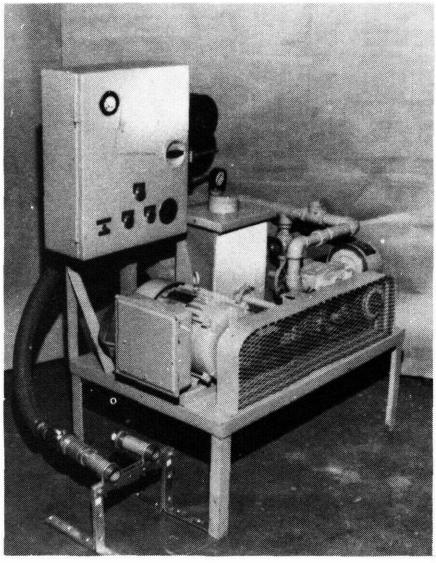
Figure 19.—Hopper-bottom crib with a drag chain dispenses ear corn.



PN 4900

Figure 20.—The medium-pressure pneumatic conveyor is a convenient method of transporting ground feed material. Less air is used per pound of transported material and less dust collects at the discharge point.

- A conveyor can deliver feed to an auger mounted above a feed bunk which will distribute the feed throughout the bunk (fig. 22).
- A conveyor can deliver feed to a bunk equipped with an endless chain or belt that is pulled through the bottom of the bunk and returned underneath, or by a shuttle stroke conveyor that pushes the feed in the bunk.

Auger, chain, belt, or shuttle conveyors can also distribute silage throughout a feed bunk.

Automatic Controls

Low-horsepower, low-capacity, electrically powered equipment—designed to process feed at low rates over maximum periods of time—is practical for feed prepara-

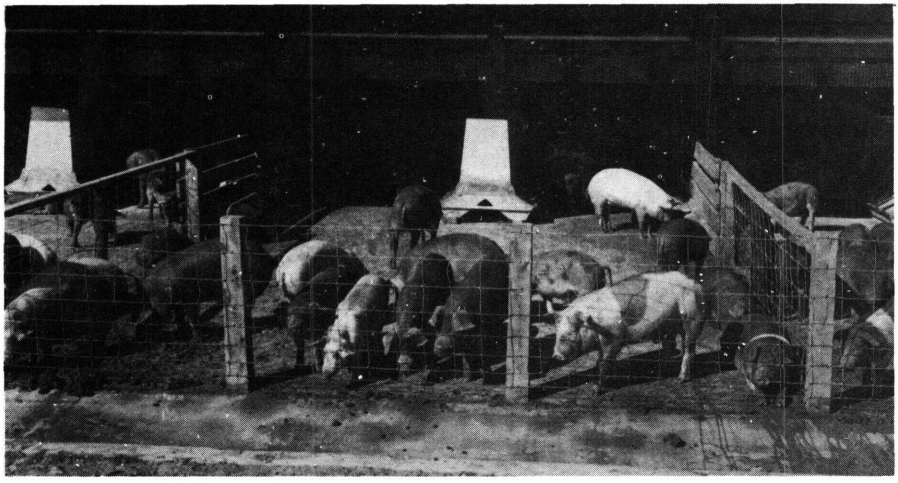


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Figure 21.—Unlike pneumatic conveyors, auger conveyors distribute feed to several outlets in succession without adjustment.

tion and distribution systems. For the most efficient and economical operation, the equipment should be automatically controlled.

Only minimum supervision or manual operator control is required when simple and inexpensive electric controls regulate and synchronize the equipment. The simplest and most useful controls include the time switch (24-hour repeat cycle timer and interval timer), the time-delay relay, and the pressure switch.

Time Switch

A time switch regulates the frequency and duration of the feed-processing operations—that is, the number of operations per day, per week, or per any time base desired and the length of time for each operating period.

Figure 23 shows a 24-hour time switch or clock. It can activate a feed-processing system every hour or any hour of the day for a period of 2 to 55 minutes.

Figure 24 shows an interval timer, which can time individual operations. It is manually set for the desired operating period (10 minutes to 5 hours), and at the end of that time, the interval timer breaks the circuit.

Time-delay Relay

Figure 25 shows a time-delay relay that can control the operating sequence of equipment in feed processing and distributing systems. Starting and stopping several pieces of equipment in a definite order is often necessary. For example: A grinder feeds material into a conveyor. To prevent plugging of equipment, the conveyor must start several seconds before the grinder at the beginning of the feed-processing operation and stop several seconds after the grinder at the end of the operation.

Pressure Switch

Figure 26 shows a pressure switch that can be used as the primary control or safety device in an automatic feeding system. Operation is simple: Pressure or nonpressure of material on the switch pressure plate opens or closes the electric circuit. Installed in a feeder or bin, the switch can start the feed-preparation and conveying system when the feeder or bin is emptied and can stop the system when the feeder or bin is full.

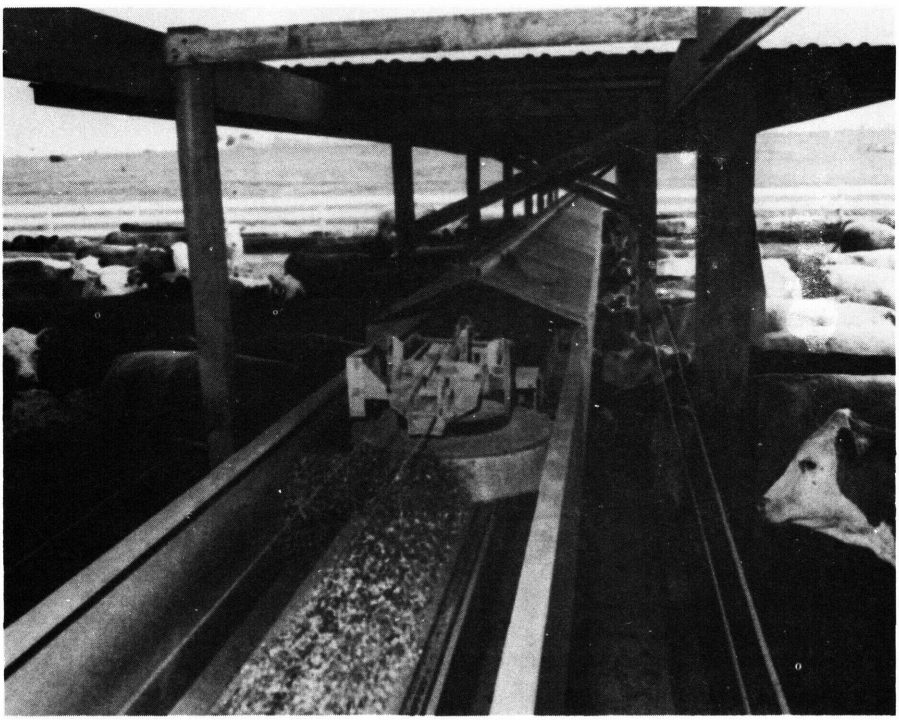
Interlocking of electric controls in an automatic feeding system through the proper combination of relays and switches is important to prevent improper operation that could damage the equipment or cause feed to be delivered to the wrong point.

PLANNING A FEEDING SYSTEM

An automatic feeding system reduces feeding costs, saves labor, eliminates undesirable tasks, and rations feed according to the desired quality and quantity.

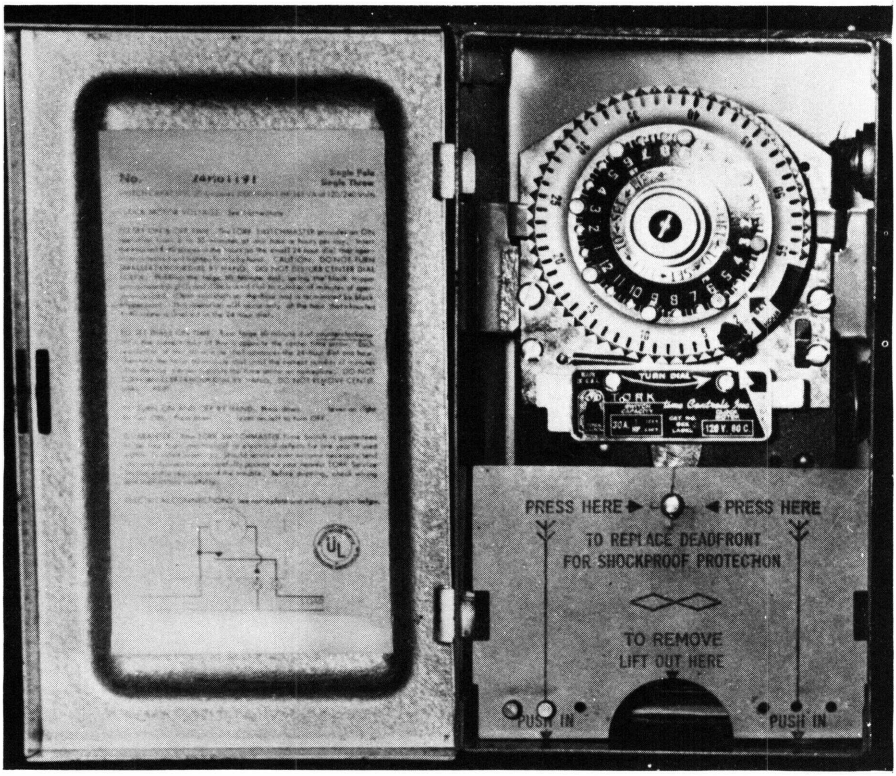
No single system can work for every livestock or poultry feeding operation. Each system must be installed according to the particular feeding requirements and existing facilities and equipment.

Consult your county agent, pow-



PN 4902

Figure 22.—The belt distributor is a convenient method of moving bulky as well as finely ground feed to livestock.



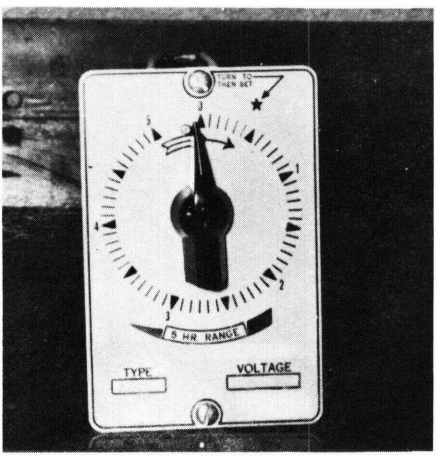
PN 4903

Figure 23.—Time clocks are useful controls for automating feeding operations.

er supplier, and equipment dealer for advice and assistance. Some equipment dealers offer complete planning, installation, and maintenance services for automatic feeding systems. Frequently, all equipment required or desired is available from one dealer.

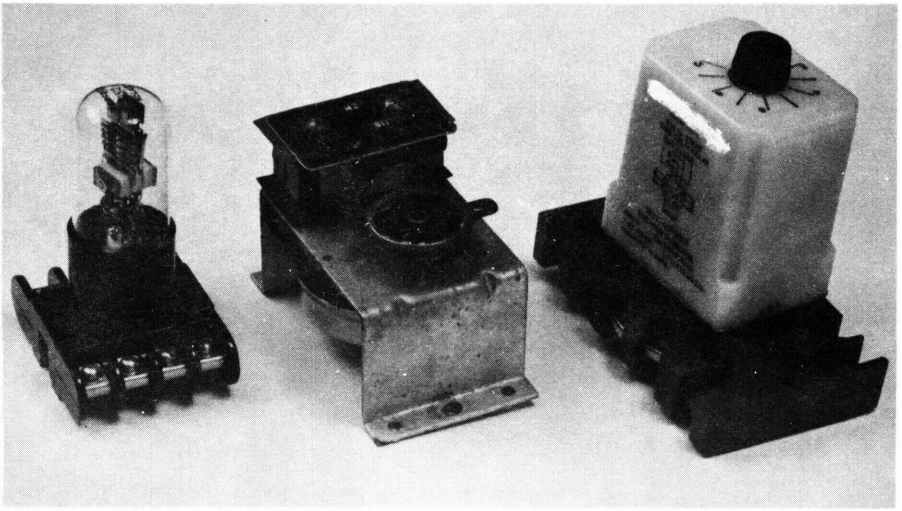
Circumstances may permit installation of only part of the system at a time. Nevertheless, a complete plan of operations should be drawn up so that equipment can be added with minimum change.

The plan would cover information on type and number of animals to be fed, kind and quantity of feed



PN 4904

Figure 24.—Interval timers, electric or spring drive, time individual operations.

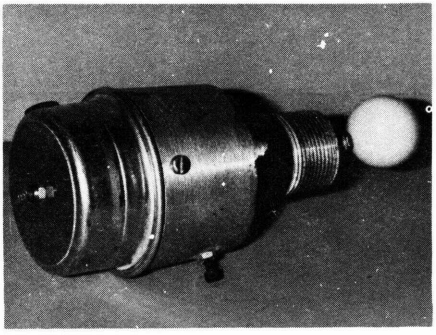


PN 4905

Figure 25.—Time-delay relays start and stop equipment in the proper sequence. Left, a thermostatic time-delay relay; center, a synchronous motor-driven relay; right, an electronic time-delay relay.

required, and type and amount of equipment needed to store, process, and convey the feed. The plan would also include a flow showing location and capacity of existing facilities and equipment and proposed installation of new equipment. Following are some important points to remember in designing an automatic feeding system:

- Wherever you can mechanize or automate an operation efficiently, do so.
- Move feed as little as possible and over minimum distances.
- Make the flow of feed continuous from storage to feeding points to eliminate such unnecessary operations as secondary storage.
- Review initial design for ways to increase efficiency and eliminate unnecessary operations.



PN 4906

Figure 26.—A bin switch, such as the rotary type above, or a diaphram switch can be used as the primary control or as a safety device in an automatic feeding system.

FEEDING SYSTEM EXAMPLES

Several examples of operating feeding systems are illustrated in figures 27, 28, and 29. These are typical of arrangements that have been successful.

Three feeding systems, described in the following paragraphs, have been automated to reduce or eliminate the labor required to prepare and distribute feed to livestock. However, operators must realize that automatic feeding equipment is not a substitute for livestock management and cannot replace the herdsman.

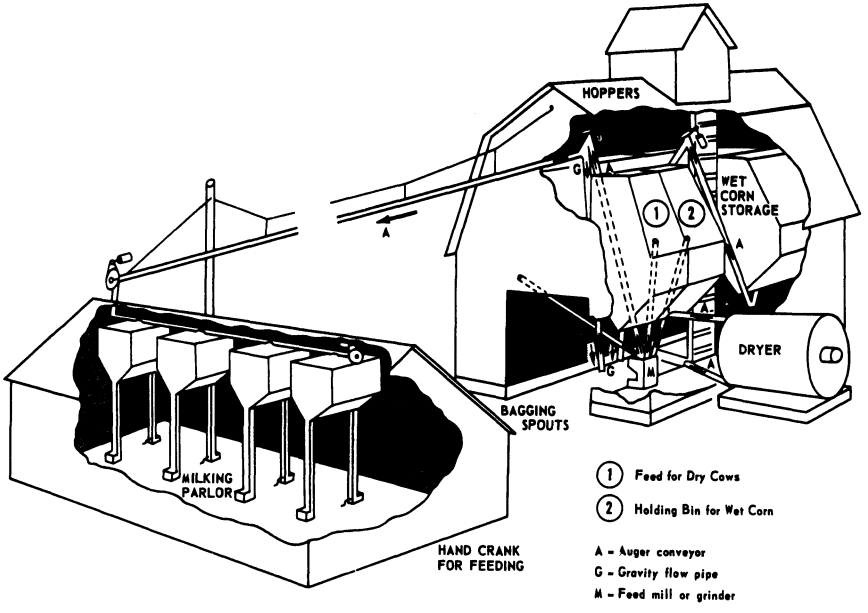


Figure 27.—This feed-handling system provides for automatic corn drying as well as automatic preparation of a dairy ration. Feed is delivered automatically to the milking parlor stalls; 240 cows are fed from this system.

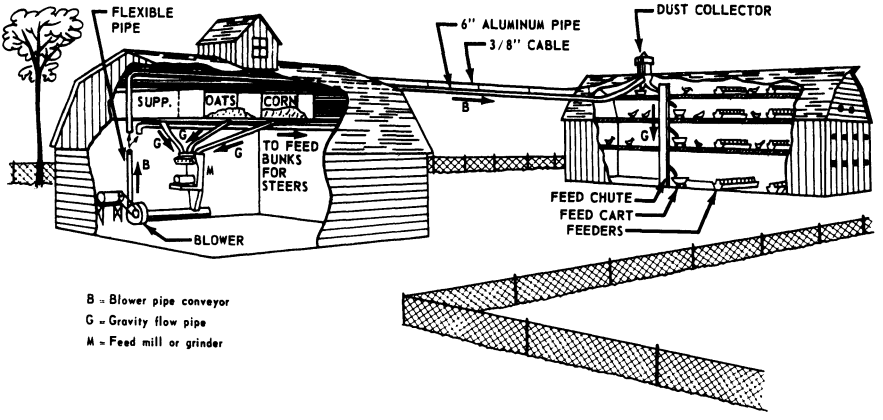


Figure 28.—This high-volume, low-pressure pneumatic conveyor system automatically feeds 30,000 broilers and 100 steers.

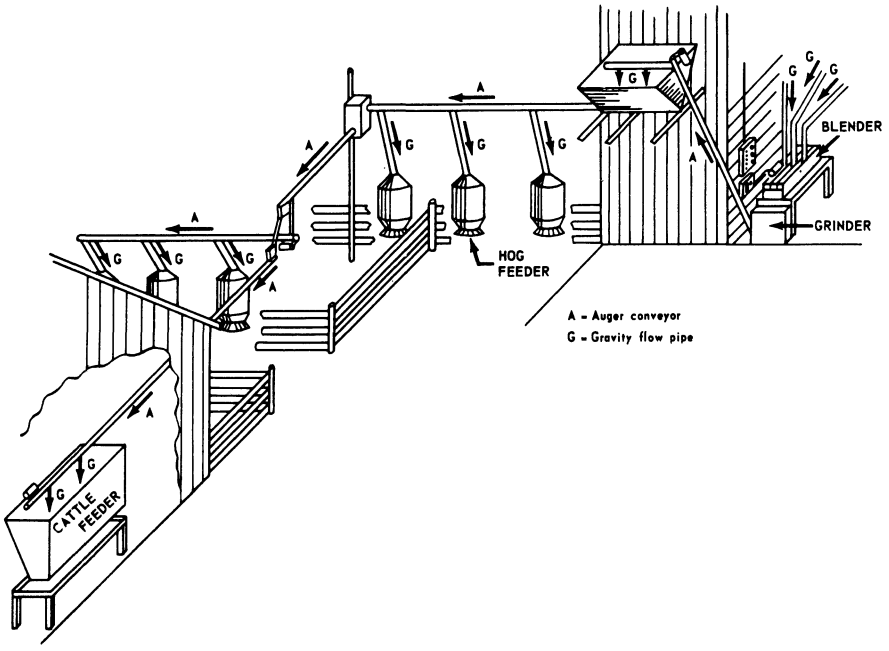


Figure 29.—This system illustrates how several different rations can be prepared and delivered by the same equipment. Note how the conveying augers are connected to change the direction of flow and extend the conveying distance; 150 beef cattle and 500 hogs are fed from this system.

Poultry Feeding System

The automatic feeding system shown in figure 30 is installed on an Illinois farm where the owner feeds approximately 30,000 turkeys yearly. Eight different feed ingredients are stored in bulk storage bins. Automatically controlled augers remove the ingredients from the bins and convey them to an automatic hammer mill with self-contained dispensers which mix and grind the feed.

The mill discharges the feed into a medium-pressure pneumatic conveying system (32 cubic feet of air per minute at 7 1/4 pounds of air pressure per square inch). Feed enters the conveying system through an auger injector airlock. An air compressor supplies the pressure which blows the feed through 1-inch, rigid, metal piping to the feeding points.

The system has two control units —one on the mill and the other on the wall. The power control unit on the mill consists of interlocked relays and safety devices that operate the equipment and prevent damage in case of malfunction. The distribution-control panel on the wall regulates distribution of the feed to the feeding points. This unit includes subassembly controls for each feeding point.

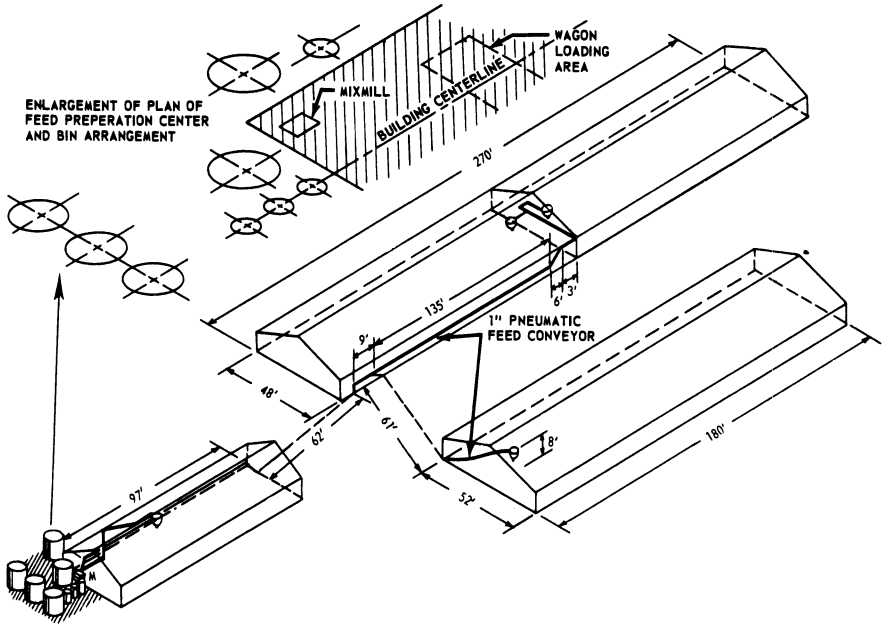


Figure 30.—Poultry feeding system used to prepare and distribute feed for 30,000 turkeys. An experimental low-volume, medium-pressure pneumatic conveyor blows the feed through 1-inch piping. Electric motors totaling 7 horsepower drive the equipment. This system is operated a maximum of 8 hours per day.

Automatically, the system prepares a feed ration containing up to four ingredients and delivers it to feeding points as far as 400 feet from the mill at a rate of 1,200 pounds per hour.

Cattle Feeding System

The automatic group feeding system on the University of Illinois dairy farm has the capacity to mix programmed rations of forage and concentrate and to deliver them to five feedlots (fig. 31) that accommodate a total of 127 cows.

Automatic subsystems proportion forage and concentrate, resupply concentrate bins through a pneumatic conveying system, control forage flow of top type silo unloaders, and feed several groups of cows in automatic sequence.

In addition to automatic feeding, storing, and distributing equipment, the system features free-stall housing and complete milking facilities: A herringbone milking parlor, pipeline milking system, and direct expansion milk-holding tank.

How the System Works

The heart of the system is the control panel (fig. 32) that monitors the preparation of five different grain-forage rations for five different feedlots. Cows can be arranged into groups of 27, 36, 20, 20

and 24 according to their production, with each group receiving a specific ration. Objectives are to eliminate individual feeding attention and to increase accuracy as much as possible.

The feed-processing center (fig. 33) includes five silage storage units, a four-bin grain storage and dispensing facility with an automatic hammer mill, a pneumatic conveying system for ground grain, and a building to house the control panel and conveying equipment. One worker can regulate rations for the 127 cattle by selecting either corn silage, alfalfa haylage, or both, plus a premix concentrate

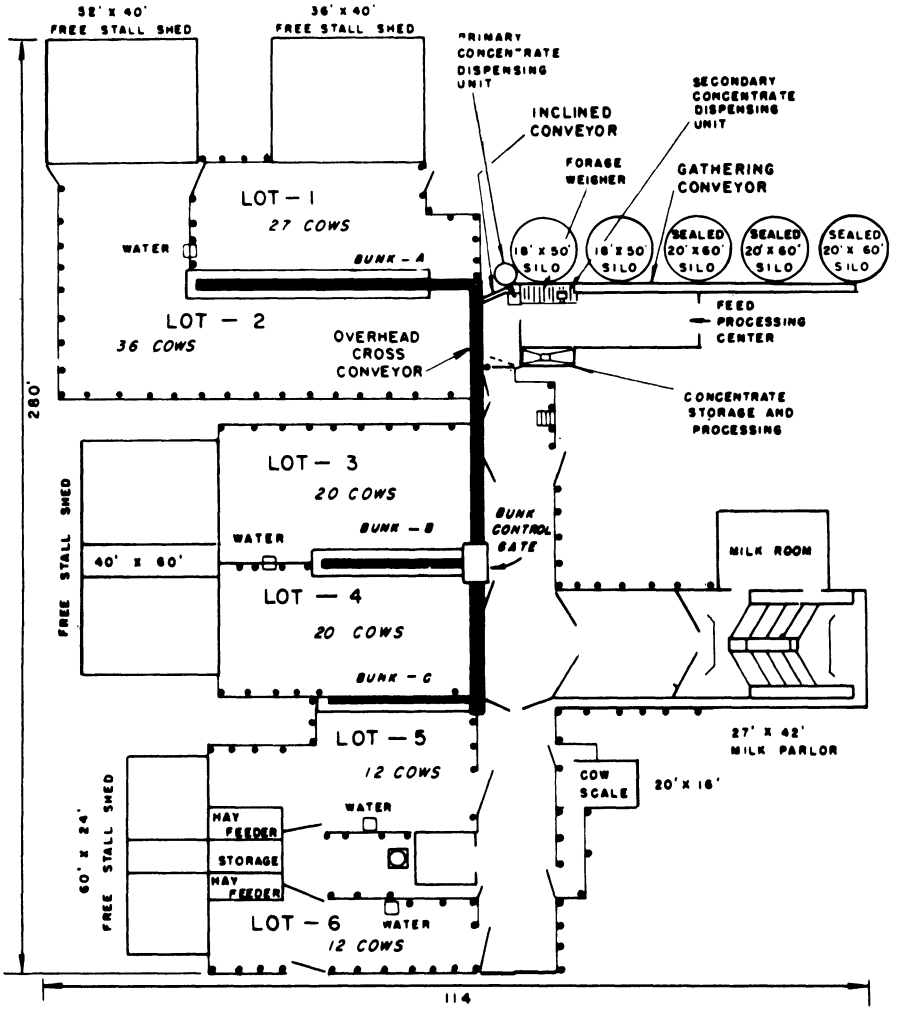
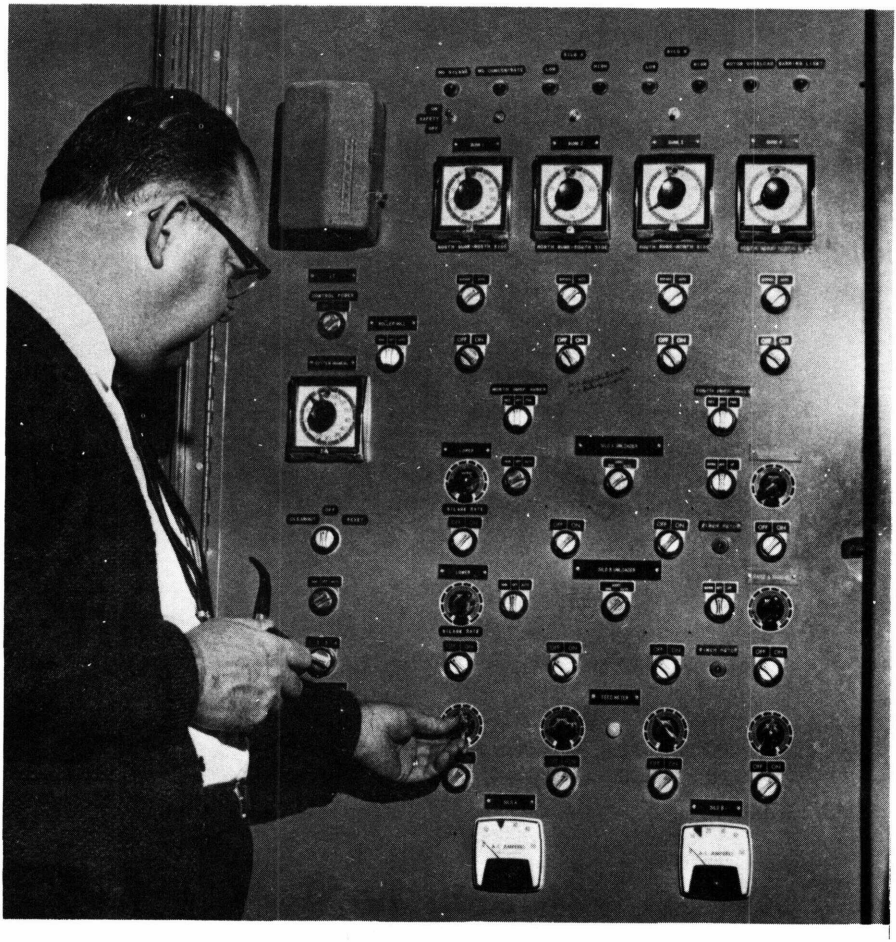


Figure 31.—Schematic of feedlot and feeding equipment. Lot-6 is not part of the group feeding system.

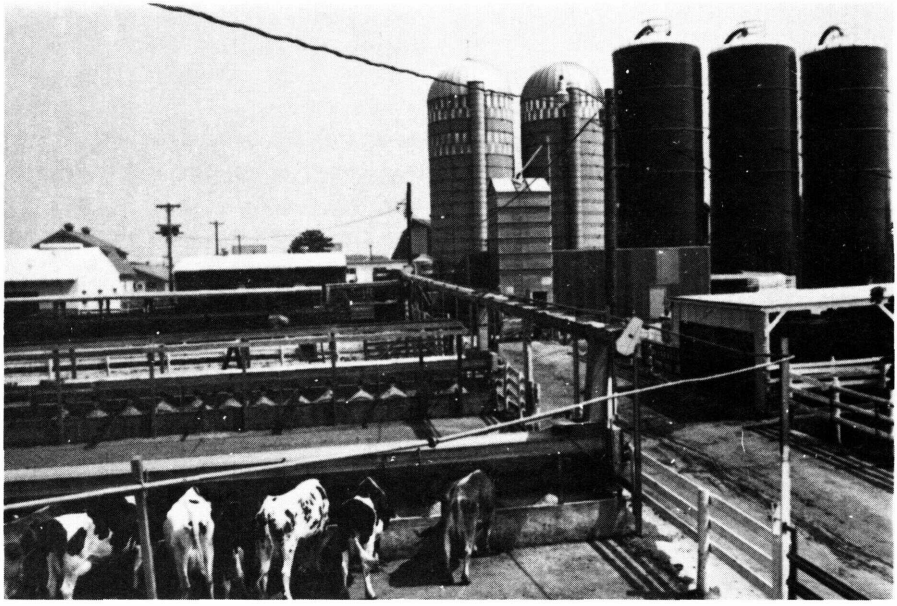


PN 4907

Figure 32.—Control panel for group feeding of dairy cows.

mixture containing up to four ingredients. According to its needs, feed can be delivered to each production group of cattle as often as every 2 hours in specific amounts programmed by the worker for each feedlot.

Forages are collected from five storage structures consisting of two top-unloaded silos and three bottom-unloaded units. The forage is conveyed on a 16-inch wide belt to the electronic forage weigher and then dropped onto the inclined conveyor. At this point the concentrate mixture is dropped onto the forage in proportion to the amount of forage moving through the system. The ratio of forage to concentrate can be adjusted from one-to-one to eleven-to-one by weight. Proportioning of forage and concentrate is done automatically with an electronic control system that uses the forage flow signal from the electronic forage weigher



PN 4908

Figure 33.—Feedlots with feed storage and preparation facilities in the right background.

to control concentrate dispenser output.

The complete ration is dropped from the inclined conveyor into the overhead 10-inch horizontal auger conveyor which delivers it to the feed bunks. Uniform feed distribution along each bunk is provided by a double-auger type feeder.

The concentrate mixture can be prepared from four grains proportioned through a commercial hammer mill. Output is pneumatically conveyed to any of several locations through a 1-inch conduit.

Individual Feeding System for Dairy Cows

An electronic feeding control system for dairy cows permits free consumption of concentrates up to a preset amount within a 12-hour period. The amount of feed available to a single animal during any 12 consecutive hours is continuously variable between the amount that can be dispensed in 1.7 to 18.7 min. At a dispensing rate of 1 lb/min this rate becomes 3.4 to 37.4 lb/day. The upper limit corresponds to the needs of a cow producing 70 lbs or more of 4 percent milk per day. Any animal on the system can receive feed from any dispensing feed stall of the system but only up to the preset amount for each cow.

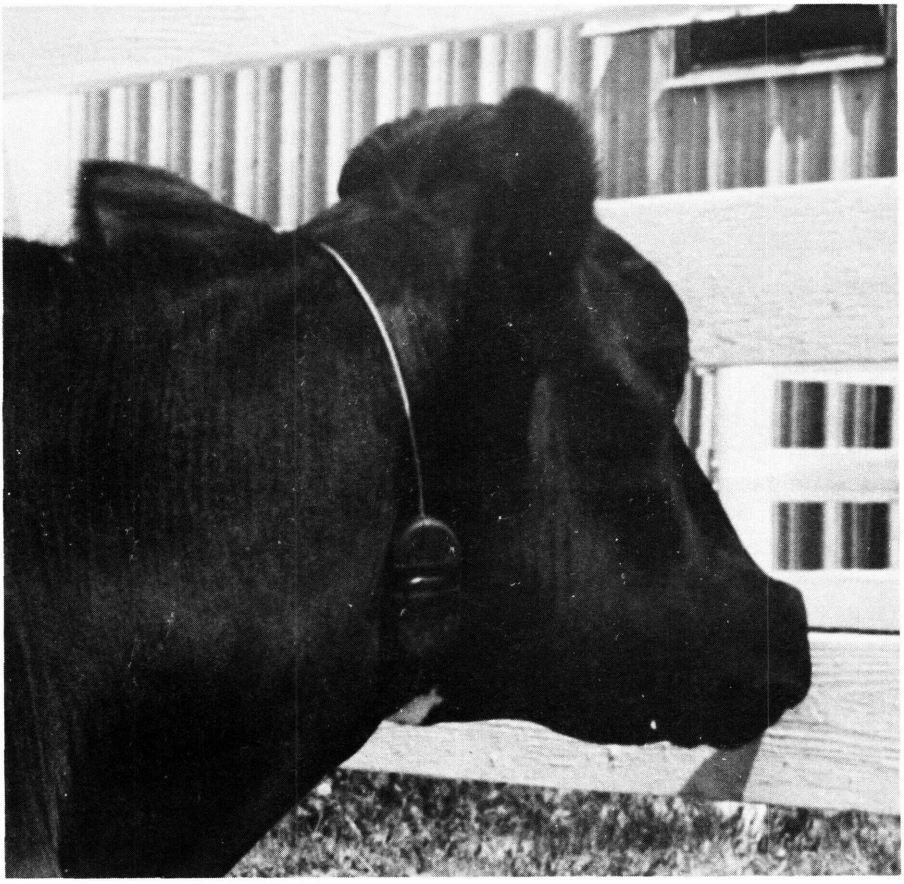
Each stall is equipped with an interrogator and a feed dispenser that is supplied from a feed storage bin. If the unit fails to operate properly, an outside light warns the herdsman of a malfunction.

This new system offers fully

automatic control of concentrate feeding by relieving the milking parlor operator of the feeding chore. The operator may milk more cows in a given period because there is no waiting for the high producer to finish eating. If cows are group fed, it is not necessary to move individual cows from one group to another to achieve a feeding rate that matches their individual changes in production.

Automatically controlling the feeding rate for an individual cow eliminates feed exposure in the parlor, which, in turn, reduces fly and sanitary problems. The electronic feeder also avoids feeding delays that result from high feeding, low consumption rates by individual cows.

Three major subsystems comprise the electronic feed control. The first subsystem is a transponder (fig. 34). This active electronic device converts high frequency power signals to d.c. voltage. It includes an oscillator that



PN 4909

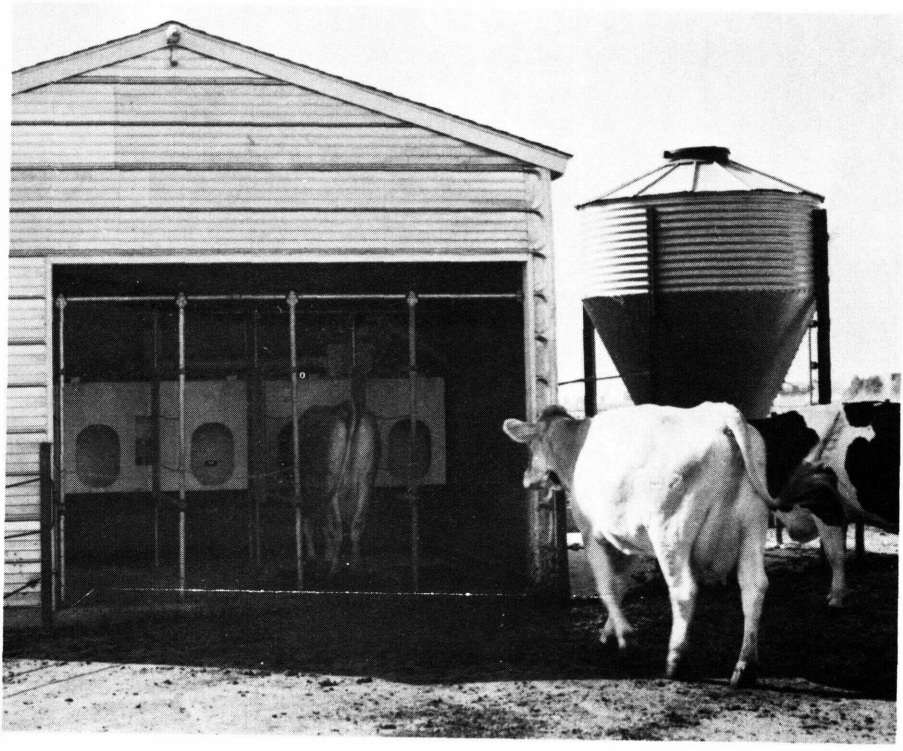
Figure 34.—Transponder attached to collar around cow's neck.

will emit a signal anytime power is received and the energy cell is not at full charge or "cut-off" voltage. The transponder is attached to a collar around the cow's neck that controls the operating time of the stall-feed dispenser within a preset period. Internally, a timing circuit controls the discharge of an energy cell (battery) at a linear rate over 12-hours—a controlled (constant current) energy cell recharge circuit.

The second subsystem, an interrogator, transmits high frequency power to the transponder and receives its signal. When a transponder signal is received, the interrogator will activate the feed dispenser.

The third subsystem, a controllable feed dispensing station, consists of a feed dispenser, bulk feed storage source, and stall to protect the feeding animal from unwarranted interference by other animals (fig. 35).

With reasonable calibration of the feed dispenser, the total error will be below 5 percent. This is much better control than can be exercised with normal inparlor feeding systems. Performance tests conducted with milking cows show



PN 4910

Figure 35.—Feed dispensing stations may consist of one or more stalls.

no significant difference in milk production for cows hand fed in parlor feeding groups according to production as compared to cows fed individually with the electronic feeder control.

Some automatic feeding systems are powered by electric motors. Comprehensive and detailed information on electric motors is available in Farmers' Bulletin No. 2257, "Selecting and Using Electric Motors." Single copies of this publication—prepared by the Agricultural Research Service—can be obtained free from your county extension agent or by writing to the Office of Communication, U.S. Department of Agriculture, Washington, D.C. 20250. Send your request on a post card. Be sure to include your ZIP code.

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